UNIVERSITI PUTRA MALAYSIA

TELEMEDICINE: BLOOD PRESSURE MONITORING SYSTEM FOR INDIVIDUAL USE THROUGH INTERNET

WAGIE ALLAH AHMED ELOBEID

TELEMEDICINE: BLOOD PRESSURE MONITORING SYSTEM FOR INDIVIDUAL USE THROUGH INTERNET

By

WAGIE ALLAH AHMED ELOBEID

Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

January 2000

Dedicated to

My

*Parents, Brothers and Sister*s

Abstract of thesis submitted to the senate of University Putra Malaysia in Partial fulfillment of the requirements for the degree of Master of Science

TELEMEDICINE: BLOOD PRESSURE MONITOPRING SYSTEM FOR INDIVIDUAL USE THROUGH INTERNET

By

WAGIE ALLAH AHMED ELOBIED

January 2000

Chairman: **Ishak Bin Aris, Ph.D.**

Faculty: **Engineering**

Hypertension and Hypotension are common diseases in Malaysians and the world at large. If not treated, they predispose the patient to more serious conditions like coronary heart disease and stroke. Regular blood pressure monitoring at home can be helpful in the management of the diseases. Doctors can use the data to evaluate the patient's condition and institute treatment.

In this project, an Internet-based Blood Pressure Monitoring System (IBPMS) was developed, as a new application in telemedicine, for monitoring the patient's blood pressure at home. The data is automatically sent to the hospital database via the Internet.

This system consisted of both hardware and software. A serial interface card connected to a blood pressure device was designed and tested. The software, which included a graphical display of blood pressure and homepage, was developed.

The IBPMS system was designed and tested. The software, Visual Designer, was used to create the system, graphical display and control the operation of the interface card, while Hyper Text Mark-up Language (HTML) was used to develop the homepage.

The complete IBPMS has been designed and experimentally tested with four subjects of ages from 25 to 30 years old. The measurement has been taken under the required room temperature and proper setting. Then these results have been compared with the real readings by using Omron blood pressure monitoring device. The difference is found to be within the range of the standard error.

Thus, it can be stated that the developed IBPMS system is a convenient tool to patients for regular blood pressure monitoring at home and an important and useful application to the telemedicine service.

Abstrak tesis yang dikemukakan Senat Univesiti Putra Malaysia sebagai memenuhi sebahagian daripada keperluan untuk ijazah Master Sains

TELE-PERUBATAN: SISTEM MEMANTAU TEKANAN DARAH UNTUK KEGUNAAN PERSEORANGAN MELALUI INTERNET

Oleh

WAGIE ALLAH AHMED ELOBIED

January 2000

Pengerusi: **Ishak Bin Aris, Ph.D.**

Fakulti: **Kejuruteraan**

Hipertensyen dan hipotensyen adalah diantara penyakit yang selalu menyerang rakyat Malaysia dan penduduk di kebanyakan negara-negara di dunia. Sekiranya keadaan ini tidak dirawati dengan sewajarnya, ianya akan menyebabkan penyakit yang lebih merbahaya seperti sakit koronari jantung dan jantung. Kekerapan pemeriksaan tekanan darah yang dilakukan di rumah boleh membantu dalam menangani hipertensyen dan hipotensyen. Para doktor boleh menggunakan rekod-rekod tekanan darah pesakit dalam menilai kesihatan pesakit dan rawatan yang perlu dilaksanakan.

Projek ini adalah berkenaan dengan pembangunan sistem memantau tekanan darah untuk kegunaan perseorangan melalui Internet (IBPMS). Ianya adalah satu aplikasi baru di dalam tele-perubatan. Sistem ini berupaya memeriksa tekanan darah di rumah pesakit itu sendiri. Data yang diperolehi kemudiannya dihantar ke pangkalan data (database) di hospital melalui Internet.

Sistem ini terdiri daripada perkakasan dan juga perisian. Kad antaramuka bersiri yang digabungkan dengan alat tekanan darah telah direkacipta, dibina dan diuji. Perisian sistem ini mempunyai tingkap grafik yang boleh mempamerkan tekanan darah seseorang pesakit. Laman web juga telah dibangunkan untuk sistem ini. Tingkap grafik dan pengawalan operasi kad sistem antaramuka ini telah direkacipta dengan menggunakan satu perisian bernama 'Visual Designer'. Sementara itu, Hypertext Mark-up Language (HTML) telah digunakan untuk membangunkan laman web.

Sistem IBPMS yang lengkap telah direka-cipta dan diuji dengan mengambil bacaan tekanan darah dari empat orang dewasa yang berumur di antara 25 hingga 30 tahun. Bacaan ini diambil mengikut peraturan yang betul pada tahap suhu bilik. Apabila bacaan ini dibandingkan dengan bacaan yang diambil dengan menggunakan alat pengukur tekanan darah Omron perbezaan bacaan didapati berada pada tahap kesalahan standad.

Daripada keputusan ujian yang telah dilakukan terhadap sistem ini, ianya boleh disimpulkan bahawa sistem ini adalah berguna kepada pesakit yang memerlukan bacaan tekanan darah yang diambil pada kadar yang kerap di rumah pesakit tersebut dan ianya juga adalah sistem yang penting dan berguna kepada tele-perubatan.

ACKNOWLEDGEMENT

First of all, I would like to thank our mighty god for providing me a good health and unlimited ideas in my life. I hope the outputs of this project will contribute to the welfare of human kind.

I would like at this juncture to express my deepest appreciation and gratitude to my kind supervisor Dr. Ishak Bin Aris, who kept advising and commenting through out this project until it be come a real success. Thanks and appreciation are extended to the members of the supervisory committee Dr. Norman Bin Mariun, and Assoc. Prof. Dr. Jammal Ahmad Essa. Great appreciation is expressed to Mr. Yasin and other technicians of Electrical and Electronic Engineering Department for their technical support and valuable suggestions. My appreciation is also extended to the Faculty of Engineering for providing the facilities and the components required for undertaking this project.

I would like to thank the staff at the Graduate School Office for their help and cooperation. Last but not least I would like to thank my family and my friends for the encouragement and support, without which, it is impossible for the success of this project.

I certify that an Examination Committee met on 4th January, 2000 to conduct the final examination of Wagie Allah Ahmed Elobeid, on his Master of Science thesis entitled "Telemedicine: Blood Pressure Monitoring System For Individual Use Through Internet" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Committee are as follows:

BARKAWI BIN SAHARI, Ph.D., PEng.
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

ISHAK BIN ARIS, Ph.D.
(Lecturer)
Faculty of Engineering
Universiti Putra Malaysia
(Member)

NORMAN BIN MARIUN, Ph.D., PEng.
Faculty of Engineering
Universiti Putra Malaysia
(Member)

JAMMAL AHMED ESSA, Ph.D.
Professor/Dean of Faculty of Medicine and Health Science
Universiti Putra Malaysia
(Member)

MOHD GHAZALI MOHAYIDIN, Ph.D.
Professor /Deputy Dean of Graduate School
Universiti Putra Malaysia

Date: 22 JAN 2000

This thesis submitted to the Senate of Universiti Putra Malaysia and was accepted as Partial fulfilment of the requirements for the degree of Master of Science.

KAMIS AWANG, Ph.D.
Associate Professor/Dean of Graduate School
Universiti Putra Malaysia

Date: 10 FEB 2000

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I declare that this thesis has not been previously or concurrently submitted for any other degree at UPM or any other institutions.

(Wagie Allah Ahmed Elobeid)

Date: January 4, 2000

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADC	Analog- to- Digital Converter
ABPM	Ambulatory Blood Pressure Monitoring
ATM	Asynchronous Transfer Mode
BPM	Blood Pressure Monitoring
BPS	Bits Per Second
CD	Carrier Detect
CPU	Central Processing Unit
CPR	Computer- based Patient Record
CMOS	Complementary Metal Oxide Semiconductor
CTS	Clear to Send
CGI	Common Gateway Interface
DAC	Digital- to- Analog Converter
DBP	Diastolic Blood Pressure
DBMS	Database Management System
DOS	Disk Operator System
DC	Direct Current
DTE	Data Terminating Equipment
DCR	Data Communication Ready
DTR	Data Terminal Ready
EEG	Electroencephalograph
ECG	Electrocardiograph
EMG	Electromyography
EIA	Electronic Industry Association

FTP	File Transfer Protocol
HTML	Hyper Text Mark-up Language
HTTP	Hyper Text Transfer Protocol
ICU	Intensive Care Unit
I/O	Input/ Output
ITU	International Telecommunication Union
IBPMS	Internet-based Blood Pressure Monitoring System
IC	Integrated Circuit
IP	Internet Protocol
JVM	Java Virtual Machine
LSB	Least Significant Bit
LAN	Local Area Network
MAP	Mean Arterial Pressure
NASA	National Aeronautics and Space Administration
NLM	National Library of Medicine
OOP	Objective Oriented Programming
PBS	Public Broadcasting System
PC	Personal Computer
RAM	Random Access Memory
RMS	Root Mean Square
RD	Read
RI	Ring Indicator
RTS	Request to Send
SBP	Systolic Blood Pressure
SG	Signal Ground

STAPAHC	Space Technology Applied to Rural Pagpago Advanced Health Care
SGML	Standard General Mark-up Language
SIPO	Serial in, Parallel out
SNR	Signal to Noise Ratio
TTL	Transistor Transistor Logic
TBR	Transmitter Buffer Register
TCP	Transmission Control Protocol
UART	Universal Asynchronous Receiver Transmitter
URL	Universal Resource Locate
WAN	Wide Area Network
WHO	World Health Organization
WR	Write
WWW	World Wide Web

CHAPTER I

INTRODUCTION

Telemedicine is a new field in medical technology. Using a combination of information electronics and telecommunications, it allows medical consultation from afar. It is essentially the transfer of medical data (images, sounds, records, etc.) electronically, allowing consultation in video conferencing. The transfer of data is by one of several means - Internet, Intranet, satellites and telephony. However, telemedicine is not only the transmission of data, but also related activities like information search, data storage and retrieval and discussion. Telemedicine has been used for education, diagnosis, monitoring, cardiology, surgery and pathology, just to name a few of the varied to uses.

Some of the commercial applications related to the telemedical system include telecardiology, telespirrometry, teledialysis, telemonitoring of oxygen therapy at home, telesurgery, telediagnosis, teledermatology, tele-education, teleradiology, telepharmacy and telepathology.

Why Telemedicine is Needed in Health Care

As telemedicine allows medicine and health care to be practised from afar, it is a boor for countries short of medical expertise. In the developed countries, there is a doctor for every 200 to 500 people, but in some third world countries only one doctor to 6000 people. In Malaysia, although the doctor: population ratio in Kuala-Lumpur matches that in the West, the same cannot be said for the rural areas, especially in Sabah (Mehrdad *et al.*, 1999). The health services in poor countries are far from well distributed.

Telemedicine can therefore be used to improve the medical care by:

1) allowing home medical care,
2) improving access to medical expertise,
3) improving the health service, and
4) reducing the cost.

Technologies such as telephony, computing, monitoring devices and iterative video can be combined to provide a home health system extremely useful in after care and for monitoring a chronic illness. It will also encourage better use of the health service as many people prefer the anonymity of the computer to personally seeing a physician (Moore, 1998).

Nevertheless, the 'computer' will still allow consultation between the referring physician, consulting physician, patient and even the patient's family through interactive video with information on the patient available on line. The patient's physician or health care personnel, in his remote location, can be informed of or even included in the consultation for the better care of the patient (Olga, 1998).

Telemedicine also reduces the travel cost for the patient. Telehealth is introduce in health care and is defined as the use of telecommunication for the delivery of heath care services across distance. These services may include patient consultations, education, administrative services, or collaborative research. Telemedicine is subset of telehealth (Moore, 1998). Telemedicine uses telecommunication to provide medical and health cares, expedite research, and improve the diagnosis and treatment of illness.

Objectives of the Project

This project aims to:

1) Develop a serial interface card,
2) Modifying the blood pressure device to convert the output for digital signal to analogue signal, and
3) Develop a blood pressure web-site with a database of medical information on blood pressure.

Thesis Layout

This thesis is organised in five chapters. Chapter I gives a short introduction to the work and its objectives.

Chapter II is a literature review on high blood pressure and related diseases, blood pressure monitoring methods and blood pressure amplifiers. The background of telemedicine, its advantages and disadvantages, and associated telemedicine applications are discussed. A general description of the system, serial interface cards, homepage operation and construction is given. Emphasis is given to the serial interface card and homepage as they were specifically developed for this project. A brief server network for the Internet, web-page design and network analysis, Internet and medical computer information is described.

In Chapter III, the design of the serial interface card and software written are presented. The design of the main system and a description of the components required follow this. The system homepage was created using HTML. The linkage module between the homepage and blood pressure monitored is accessed using the Visual Designer, Java applet and HTML.